IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s):	**Jeffrey B. Johnson, et al.**	**Examiner:**	**Dana Farahani**
Serial No:	**09/866,319**	**Art Unit:**	**2814**
Filed:	**May 25, 2001**	**Docket:**	**BUR920010011US1 (14331)**
For:	**PROCESS FOR MAKING A HIGH VOLTAGE NPN BIPOLAR DEVICE WITH IMPROVED AC PERFORMANCE**	**Dated:**	**April 20, 2004**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPELLANTS' BRIEF ON APPEAL

1. Real Party in Interest

The real party in interest of the present application is International Business Machines Corporation, the assignee of the entire right, title and interest in the above-identified patent application.

2. Related Appeals and Interferences

No other appeals or interferences are known which directly affect, or will be directly affected by, or have a bearing on, the disposition of the pending appeal.

3. Status of the Claims

The present application was filed on May 25, 2001 with Claims 1-44. A first Office Action on the merits issued February 26, 2002, to which Appellants filed a response dated May 28, 2002. In response to a Final Rejection dated July 17, 2002, Claim 1 was canceled,

Claims 2-6, 8, 12, 13, 15, 22-30, 32, 34, 37 and 38 were amended for the first time and Claim 45 was added. These actions were performed in Appellants' Response under 37 C.F.R. §1.116 dated September 17, 2002. The amendments to Claims 2-6, 8, 12, 13, 15, 22-30, 32, 34, 37 and 38 and newly added Claim 45 were not entered in the Advisory Action dated October 16, 2002. A Request for Continued Examination (RCE) was filed on November 18, 2002, requesting entry of newly added Claim 45 and the amendments to Claims 2-6, 8, 12, 13, 15, 22-30, 32, 34, 37 and 38 made in Appellants' Response of September 17, 2002.

In response to the Office Action that issued on January 30, 2003 in the RCE, Appellants filed a Response dated May 30, 2003. A Final Rejection was issued on August 20, 2003. No amendments to the finally rejected claims were submitted with Appellants' Response dated November 19, 2003. An Advisory Action was issued on December 31, 2003 in which the Examiner maintained his position. In response to the Final Rejection (dated August 20, 2003) and the Advisory Action (dated November 19, 2003), Appellants filed a Notice of Appeal on January 20, 2004.

Thus, Claims 2-45 are the subject of this appeal; these claims, as they presently stand, are set forth in the Appendix of this Appeal Brief. The status of each of the claims is thus as follows:

Claims 1: Canceled on September 17, 2002.
Claims 2-45: Finally rejected and on appeal.

4. Status of the Amendment

A Response to the Final Rejection dated August 20, 2003 containing arguments for patentability was filed on November 19, 2003. No amendments to the claims were filed with the November 19, 2003 Response; hence that Response was entered and considered by the Examiner.

5. Summary of Invention

The invention embodied by Claims 2-45, on appeal, relates to a SiGe heterojunction bipolar transistor, and a method of making the same, in which the SiGe heterojunction bipolar transistor has improved AC performance. The SiGe heterojunction bipolar transistor of the present application (See Fig 1), as recited in Claim 24, on appeal, comprises an emitter 28, a base 22, a collector 14, a base-emitter junction, and a base-collector junction, wherein the collector 14 comprises a subcollector 12, a deep collector 16 and a n-type dopant region 18 between the sub-collector 12 and the base-collector junction, the n-type dopant region 18 is located atop and in contact with the deep collector 16 and has a vertical width (W) sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when the base-junction is forward biased.

Appellants disclose that the n-type dopant region 18 improves the AC performance of a SiGe heterojunction bipolar transistor as well as the speed and ruggedness of the transistor. Referring to Page 7, lines 17-20, of the present application, Appellants disclose that "the inventive n-type region is doped heavy enough to significantly delay the onset of the Kirk effect, yet narrow enough to avoid creating a high-electric field region of sufficient duration to degrade the breakdown characteristics of the device".

The Kirk effect, i.e., base pushout, occurs at high current and is the effective widening of the base region of the device and causes a dramatic increase in the transit time of the carriers in the transistor. The Kirk effect occurs when the current density of carriers through the base collector region exceeds the charge density in the depletion region.

The breakdown voltage is the voltage at which the current within the device increases uncontrollably and the device loses its ability to exhibit switching behavior. Breakdown occurs when additional carriers create an electric field, where the electric field accelerates the charge carriers. As the charge carriers are accelerated, they collide with lattice ions creating additional charge carriers, which may impart additional charge carriers

creating an avalanche effect that destroys the switching nature of the device, since the increasing number of charge carriers results in an uncontrollably increasing current.

In conventional semiconductor device processing, there is a tradeoff between the Kirk effect and breakdown voltage. Appellants overcome the tradeoff between these properties using a narrow profile n-type dopant region to reduce the Kirk effect without reducing the breakdown voltage. The narrow profile n-type region has a reduced number of charge carriers and therefore does not increase the number of charge carriers to a level that would result in substantial breakdown voltage.

Appellants further disclose, referring to Page 3, line 21, that these and other objects and advantages are achieved in the present invention by a method comprising a low-energy, medium-dose n-type dopant implant after formation of the sub-collector region 12 so as to create a very narrow, medium-dose spike (n-type region 18) in the low-doped collector region of a high-voltage heterojunction bipolar transistor.

The method of forming the SiGe heterojunction bipolar transistor of the present application (See Figs 2A-2D), as recited in Claim 45, on appeal, comprises the steps of providing a structure including at least a sub-collector region 12, a collector region 14 and isolation regions 20, the collector region 14 including a deep collector region 16 located therein; forming a n-type dopant region 18 within the collector region 14 so as to be in contact with the deep collector 16, the n-type dopant region 18 having a vertical width (W) sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased; forming a base 14; and forming an emitter 26.

6. Issues on Appeal

I. Does U.S. Patent No. 6,316,818 to Marty, et al. anticipate Appellants' structure, as recited in Claims 24, 25, 28, 30, 32, 34-36, 39-41, and 43, on

appeal, or Appellants' method, as recited in Claims 45, 6, 8, 12, 13, 15, 16, 19, and 23, on appeal?

II. Does U.S. Patent No. 6,316,818 to Marty, et al. render Claims 2, 3, 14, 22, 26, 27, and 33, on appeal, unpatentable under 35 U.S.C. §103(a)?

III. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 5,252,841 to Wen, et al. render Claims 5 and 29, on appeal, unpatentable under 35 U.S.C. §103(a)?

IV. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 5,541,444 to Ohmi, et al. render Claims 7 and 31, on appeal, unpatentable under 35 U.S.C. §103(a)?

V. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 3,924,265 to Rodgers render Claims 9, 10, 37 and 38, on appeal, unpatentable under 35 U.S.C. §103(a)?

VI. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 6,329,704 to Akatsu, et al., render Claim 11, on appeal, unpatentable under 35 U.S.C. §103(a)?

VII. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 6,020, 245 to Sato render Claims 17 and 42, on appeal, unpatentable under 35 U.S.C. §103(a)?

VIII. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al., U.S. Patent No. 6,020,245 to Sato, and U.S. Patent No. 6,476, 446 to Ju render Claim 18, on appeal, unpatentable under 35 U.S.C. §103(a)?

IX. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 6,429,489 to Botula, et al. render Claims 20 and 44, on appeal, unpatentable under 35 U.S.C. §103(a)?

X. Do the combined disclosures of U.S. Patent No. 6,316,818 to Marty, et al. and U.S. Patent No. 6,410,984 to Triveda, et al., render Claim 21, on appeal, unpatentable under 35 U.S.C. §103(a)?

7. Grouping of the Claims

The Claims involved in Issue I do not stand or fall together. Claims 24, 25, 28, 30, 32, 34-36, 39-41, and 43 are related to Appellants' structure and are separately patentable from Claims 45, 6, 8, 12, 13, 15, 16, 19, and 23, which relate to Appellants' method.

The Claims involved in Issue II do not stand or fall together. Claims 2, 3, 14, and 22 are related to Appellants' method and are separately patentable from Claims 26, 27, and 33, which relate to Appellants' structure.

The Claims involved in Issue III do not stand or fall together. Claim 29 relates to Appellants' structure and is separately patentable from Claims 5, which relates to Appellants' method.

The Claims involved in Issue IV do not stand or fall together. Claim 31 relates to Appellants' structure and is separately patentable from Claim 7, which relates to Appellants' method.

The Claims involved in Issue V do not stand or fall together. Claims 9 and 10 relate to Appellants' method of forming a bipolar transistor. Claims 37 and 38 relate to Appellants' bipolar transistor structure. The claims relating to the method and the structure are separately patentable inventions.

The Claims involved in Issue VII do not stand or fall together. Claim 17 relates to Appellants' method of forming a bipolar transistor. Claim 42 relates to Appellants' bipolar transistor structure. The claims relating to the method and the structure are separately patentable inventions.

The Claims involved in Issue IX do not stand or fall together. Claim 20 relates to Appellants' method of forming a bipolar transistor. Claim 44 relates to Appellants' bipolar

transistor structure. The claims relating to the method and the structure are separately patentable inventions.

8. **Arguments for Patentability**

I. Marty, et al. fail to anticipate Appellants' structure, as recited in Claims 24, 25, 28, 30, 32, 34-36, 39-41, and 43, or Appellants' method, as recited in Claims 45, 6, 8, 12, 13, 15, 16, 19, and 23.

In the Final rejection dated August 20, 2003, Claims 2, 6, 8, 12, 13, 15, 16 19, 23, and 45, relating to Appellants' method, and Claims 24, 25, 28, 30, 32, 34-36, 39-41, and 43, relating to Appellants' structure, were rejected under 35 U.S.C. § 102(e) as allegedly anticipated by Marty, et al. Appellants respectfully disagree with the Examiner's conclusion that Marty, et al. anticipates Appellant's invention and submit the following.

It is axiomatic that anticipation under §102 requires the prior art reference to disclose every element to which it is applied. *In re King,* 801 F.2d 1324, 1326, 231 USPQ 36, 138 (Fed Cir, 1986). Thus, there must be no differences between the subject matter of the claim and the disclosure of the prior art reference. Stated another way, the reference must contain within its four corners adequate direction to practice the invention as claimed. The corollary of the rule is equally applicable: absence from the applied reference of any claimed element negates anticipation. *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 1571, 230 USPQ 81, 84 (Fed. Cir. 1986).

Regarding Appellants' claimed structure, Appellants submit that Marty, et al. fail to disclose an n-type dopant region having vertical width (W) that is sufficiently narrow to avoid lowering the collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when the base-junction is forward biased. Marty, et al. disclose an SIC region having a broad shallow dopant profile that necessarily includes a tail of n-type dopants extending into the base and therefore fail to anticipate Appellant's claimed structure, as recited in Claim 24, on appeal. Marty, et al. also fail to provide Appellants'

claimed method, as recited in Claim 45, because the SIC region formed in Marty, et al. is implanted through the base into the collector using a high-diffusivity dopant and high implant energy resulting in a broad shallow implant having a tail of n-type dopants extending into the base. Marty, et al. also fail to provide a transistor that avoids lowering collector-base breakdown voltage and restricts base widening when the transistor is forward biased, since Marty, et al. disclose overdoping of the collector to increase the switching speed of the device by introducing additional charge carriers at the expense of decreasing the device's breakdown voltage. Appellants' arguments are now discussed in greater detail.

(a) Appellants' structure is not anticipated by Marty, et al., since the SIC region disclosed in Marty, et al., does not have a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage, as recited in Claim 24, on appeal.

Appellants' bipolar transistor comprises an n-type dopant region 18 having a vertical width (W) that is sufficiently narrow to avoid lowering the collector-base breakdown voltage and having a doping concentration sufficiently high to restrict base widening. Appellants submit Marty, et al. do not provide Appellants' structure, since Marty, et al. fail to provide an n-type dopant region having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the transistor is forward biased.

The Examiner alleges that an SIC region disclosed in Marty, et al. meets the limitation of Appellants' n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage when the base-junction is forward biased. Appellants respectfully disagree since the SIC region formed in the prior art transistor disclosed in has a broad shallow profile that necessarily includes a pronounced tail of n-type dopants extending from the collector 4 into the base region 80, 81, 82.

Marty, et al. disclose a bipolar transistor including an overdoped selectively implanted collector (SIC) region, where the SIC region is formed by a process requiring a high-energy implant and a light (high-diffusivity) ion, such as phosphorus. *See* Col. 3, line 66. The high implant energy and light ion are required in the prior art to produce the SIC

region, since the SIC region is formed by implanting the light (high-diffusivity) ion into the collector 4 through the base region 80, 81, 82 of the transistor.

Appellants submit that a broad shallow profile of the SIC region results from the combination of the light (high-diffusivity) dopant ion and high-energy implant necessary to implant SIC dopants through the base region 80, 81, 82, as disclosed in Marty, et al. Subsequent spreading of the highly mobile light ion during high temperature processing forms a broad shallow implant profile, as opposed to Appellants' n-type region having a narrow vertical width (W). Appellants further submit that a tail of n-type dopants is necessarily present in the prior art transistor extending from the SIC region into the base 80, 81, 82. Although not depicted in the drawings provided in Marty, et al., the tail of n-type dopants is present, since the SIC region is formed by implanting the high-diffusivity n-type dopants through the base 80, 81, 82 into the collector 4. Therefore, since the SIC region disclosed in Marty, et al. has a broad shallow dopant profile that necessarily includes a tail of n-type dopants contacting the base 80, 81, 82, Marty, et al. fail to disclose an n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage when the device is forward biased.

For the reasons mentioned above, it is respectfully submitted that Marty, et al., do not disclose Appellants' claimed structure including an n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and therefore does not anticipate Claim 24, on appeal.

(b) Marty, et al. fail to anticipate Appellants' method, since Marty, et al. disclose forming an SIC region by implanting SIC dopants through the base into the collector using a light (high-diffusivity) dopant and high implant energy, in which the resultant SIC dopant profile fails to provide an n-type region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage, as recited in Claim 45, on appeal.

Appellants submit that Marty, et al. fail to anticipate Appellants' claimed method of fabricating a bipolar transistor, since Marty, et al fail to form an n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage, as recited in Claim 45.

Appellants' claimed method for fabricating a bipolar device begins by providing an initial structure including collector 14 and subcollector 12. Next, an n-type region 18 is formed by doping the collector region 14. Following the formation of the n-type dopant region 18, the base region 26 and emitter region 34 are formed. Appellants implant the inventive n-type region 18 into the collector 14 prior to the formation of the base region 26. Referring to Page 3, lines 21-24, and FIGS. 2A-2C of the specification, Appellants disclose that the inventive n-type region 18 is formed using a low-energy, medium-dose n-type dopant implant after formation of the sub-collector region 12, and prior to the formation of the base 26, to create a very narrow, medium-dose spike (n-type region 18) in the low-doped collector region 4 of a high-voltage heterojunction bipolar transistor.

It is the Examiner's position that Marty, et al. disclose Appellants' method, since Marty, et al. disclose selectively overdoping the collector 4 of a bipolar device to increase the device's speed. Appellants' disagree and submit that Marty, et al. fail to disclose forming Appellants' n-type dopant region, since Marty, et al. disclose overdoping the collector following the formation of the base using of a high-diffusivity dopant and high implant energy.

Marty, et al. provide a method for making a bipolar transistor, which includes providing a Si substrate 1 in which an extrinsic collector buried layer 2 is formed atop the surface of the Si substrate 1. An epitaxial monocrystalline intrinsic collector 4 is then formed atop the extrinsic collector buried layer 2. Following the formation of short trench isolation regions 5, three material layers 80, 81, 82, are deposited atop the structure, which later form the base region of the device. The three material layers that subsequently form the base region include a first layer of undoped Si 80; a second layer of SiGe 81; and an epitaxial layer of p-doped silicon 82. An oxide layer 9 and a nitride layer 10 are then

deposited atop the material layers and etched to form a zone 100. The zone 100 allows for overdoping of the underlying monocrystalline intrinsic collector region 4. Overdoping the monocrystalline intrinsic collector region 4 of the device by ion implantation forms a selective implantation collector (SIC) region.

Contrary to Appellants' method in which the n-type dopant region 18 is formed before the base region 26, Marty, et al. disclose that the SIC region is implanted after the formation of the base 80, 81, 82, in which the base 80, 81, 82 includes an undoped Si layer 80, a SiGe layer 81 and a boron doped silicon layer 82. In order to achieve this result, the forming process disclosed in Marty, et al. requires a high-energy implant and a light ion (high-diffusivity ion), such as phosphorus, to implant the n-type SIC dopant through the base 80, 81, 82 into the collector. *See* Col. 3, line 66, of the Marty, et al. disclosure. Appellants note that the only dopant disclosed in Marty, et al. for producing the SIC region is phosphorus.

Subsequent spreading of the highly mobile light ion during high temperature processing steps forms a broad shallow implant profile, that contacts the base portion of the Marty, et al. device. Additionally, although not depicted in the drawings provided in Marty, et al., implanting the n-type SIC dopant through the base region 80, 81, 82 produces a tail of n-type dopants extending through the base region 80, 81, 82 into the collector 4. Therefore, Marty, et al. fail to teach a method that produces an n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage.

For the reasons mentioned above, it is respectfully submitted that the process disclosed in Marty, et al., does not provide Appellants' claimed n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and therefore does not anticipate Appellants' method, as recited in Claim 45.

(c) Marty, et al. fail to anticipate Appellants' claimed transistor and method of forming thereof, since Marty, et al. fail to provide a transistor that avoids lowering collector-

base breakdown voltage and restricts base widening when the transistor is forward biased, as recited in Claims 24 and 45, on appeal.

Appellants submit that Marty, et al. do not provide a transistor that avoids lowering collector-base breakdown voltage and restricts base widening when the transistor is forward biased, as recited in Claims 24 and 45, on appeal. Appellants disclose that in conventional semiconductor device processing, there is a tradeoff between the Kirk effect and the breakdown voltage. *See* Page 2, lines 4-11, of Appellants' specification. As stated above, the Kirk effect, is the effective widening of the base region, which causes a dramatic increase in the transit time of the carriers in the transistor. Conventional doping of the collector with an n-type dopant reduces the Kirk effect but introduces charge carriers that provide high electric fields, which in turn degrade the breakdown properties of the device. In contrast to conventional transistors, Appellants' n-type region 18 is doped heavy enough to significantly delay the onset of the Kirk effect, yet has a vertical height narrow enough to avoid creating a high-electric field of sufficient duration to degrade the breakdown characteristics of the device.

Appellants submit that Marty, et al. disclose overdoping the collector region to delay the onset of the Kirk effect at the expense of reducing the breakdown voltage of the device, similar to the prior art disclosed in the Background of Invention section of Appellants' specification. Referring to Col. 4, lines 1-5, of the Marty, et al. disclosure, the SIC region formed is *overdoped* by one or more implant steps in an effort to increase the switching speed of the device by implanting additional charge carriers. Marty, et al. disclose implanting phosphorus into the collector of the transistor to increase the switching speed of the device without providing any instruction for avoiding a reduction in the breakdown voltage.

Breakdown occurs when the additional carriers create an electric field, where the electric field accelerates the charge carriers in a manner that degrades the device's switching properties. By overdopping the collector with additional charge carriers, Marty, et al. are compromising the breakdown voltage of the device in order to increase the switching speed

by offsetting the Kirk effect. Therefore, since Marty, et al. disclose overdoping the collector without providing a means to control the breakdown voltage, Marty, et al. do not provide a transistor that simultaneously avoids lowering collector-base breakdown voltage and restricts base widening when the transistor is forward biased.

It is the Examiner's position that Marty, et al. avoid lowering collector-base breakdown, since the SIC region disclosed in Marty, et al. does not contact the base region. *See* Page 2, paragraph 3, of the Final Rejection dated August 20, 2003. Appellants respectfully disagree, since the SIC region formed by the method disclosed in Marty, et al. includes a tail of n-type dopants that contacts and extends through the p-type base region 80, 81, 82 of the Marty, et al. transistor. Since, the n-type dopant of the tail region and the broad shallow profile of the n-type SIC region contact the p-type base region, Marty, et al. do not provide a n-type dopant region having a vertical height sufficiently narrow to avoid lowering the breakdown voltage.

As discussed above, the tail of n-type dopants contacting and extending through the base 80, 81, 82 is necessarily present, since the SIC region disclosed in Marty, et al. is formed by implanting n-type dopants into the collector 4 through the p-type base 80, 81, 82. Appellants further note that implanting the n-type SIC dopants through the p-type base 80, 81, 82 into the collector 4 requires light, yet highly-diffusive ions. The high-diffusivity of the n-type SIC dopants ensures that n-type SIC dopants diffuse to the base region during subsequent annealing processes resulting in a broad shallow SIC region, a portion of which being in direct contact with the p-type base.

The tail of n-type dopants extending into the p-type base and the portion of the broad shallow n-type SIC region contacting the p-type base provide PN junctions that produce large electric fields when the transistor is forward biased. The high electric fields produced by these PN junctions accelerate the charge carriers of the transistor disclosed in Marty, et al. As the charge carriers are accelerated, they collide with lattice ions creating additional charge carriers, which may impart additional charge carriers creating an avalanche effect

that destroys the device' switching nature, which in turn lowers the breakdown voltage of the device.

Applying a forward bias to the transistor disclosed in Marty, et al. creates high electric fields at the PN junctions produced where the p-type base contacts the tail of n-type dopants and the broad shallow dopant profile of the n-type SIC region, wherein the high electric fields lower the breakdown voltage of the Marty, et al. transistor. Therefore, Marty, et al. fail to produce a transistor that avoids lowering collector-base breakdown voltage, as recited in Claims 24 and 45.

The forgoing remarks clearly demonstrate that the applied reference does not teach each and every aspect of the claimed invention as required by *King* and *Kloster Speedsteel; et. al.*, therefore the claims of the present application are not anticipated by the disclosure of Marty, et al.

In view of the above remarks, Appellants respectfully submit that Claims 6, 8, 12, 13, 15, 16, 19, 23-25, 28, 30, 32, 34-36, 39-41, 43, and 45, on appeal, are not anticipated by the disclosure of Marty, et al.

II. Marty, et al. do not render Claims 2, 3, 14, 22, 26, 27, and 33, on appeal, unpatentable under 35 U.S.C. §103(a).

In the Final rejection dated August 20, 2003, Claims 2, 3, 14, and 22, relating to Appellants' method, and Claims 26, 27, and 33, relating to Appellants' structure, were rejected under 35 U.S.C. § 103(a) as allegedly obvious in view of Marty, et al. Appellants respectfully disagree and submit the following.

Marty, et al. fail to teach or suggest Appellants' claimed structure, as recited in Claim 24, or Appellants' claimed method, as recited in Claim 45, since Marty, et al. fail to teach or suggest a n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage. Appellants further submit that the SIC

disclosed in Marty, et al. can not be modified to provide Appellants' n-type doping region having a vertical height sufficiently narrow to avoid lowering the collector-base breakdown voltage. Additionally, there is no motivation to modify the SIC region disclosed in Marty, et al. to provide Appellants' claimed n-type dopant region. In fact, Marty, et al. teach away from forming Appellants' inventive n-type region which avoids lowering collector-base breakdown voltage, since Marty, et al. disclose overdoping the collector region. Finally, Appellants' inventive n-type region is not a change in size that is within the level of ordinary skill in the art. Appellants' arguments are now discussed in greater detail.

(a) Appellants' structure and method are not unpatentable, under 35 U.S.C. §103(a), over Marty, et al., since the prior art reference fails to teach or suggest each and every limitation of Appellants' claimed n-type region having a vertical height sufficiently narrow to avoid lowering the collector-base breakdown voltage.

Claims 2, 3, 14 and 22, are dependent on independent Claim 45 and Claims 26, 27, and 33 are dependent on independent Claim 24. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). Appellants submit that Claims 24 and 45 are not unpatentable under 35 U.S.C. §103(a), since Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type region, as recited in Claim 45. "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate Appellants' claimed invention under 35 U.S.C. §102(e). To reiterate, Marty, et al. fail to provide a transistor structure including an n-type dopant region having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the base-junction is forward biased. Marty, et al. disclose an SIC region having a broad shallow implant profile including a tail of n-type dopants that extends into the base region and therefore does not have a

vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the transistor is forward biased, as recited in Claim 24, on appeal. Marty, et al. also disclose forming the SIC region by implanting high-diffusivity dopants through the base into the collector, forming a broad shallow n-type region having a tail of n-type dopants in the portion of the base through which the SIC dopants where implanted. Therefore, Marty, et al. fail to teach or suggest Appellants' claimed method, which provides a vertically narrow n-type dopant region that avoids lowering the collector-base breakdown voltage, as recited in Claim 45.

Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. to anticipate Appellants' claimed invention, under 35 U.S.C. §102(e), apply equally well to the obviousness rejection of Claims 2, 3, 14, 22, 26, 27, and 33, under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief concerning the deficiencies of Marty, et al. to anticipate Claims 24 and 45 are incorporated by reference.

Since Marty, et al. fail to teach or suggest each and every limitation of Appellants' method, as recited in Claim 45, or Appellants' structure, as recited in Claim 24, Marty, et al. do not render Claims 2, 3, 14, 22, 26, 27, and 33 unpatentable under 35 U.S.C. §103(a).

(b) Appellants' structure and method are not unpatentable, under 35 U.S.C. §103(a), over Marty, et al., since the selectively implanted collector (SIC) disclosed in Marty, et al. can not be modified to provide the Appellants' n-type doping region.

Appellants submit that the broad shallow implant profile of the SIC region, including the tail of n-type dopants extending into the base region disclosed in Marty, et al. can not be modified to provide Appellants' n-type dopant region 18 having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage. It is the Examiner's position, first stated on Page 10 of the Final Rejection dated August 20, 2003, that the vertical height of the SIC region may be adjusted, since Marty, et al. allegedly disclose that the SIC doping can be carried out *selectively*. Referring to Column 3, lines 65-67, and Column 4, lines 1-5, the portion of Marty, et al. cited by the Examiner, Marty, et al. disclose

that "selective overdoping of the collector under the window of the emitter can be carried out in one or more implantation steps, thus contributing to an increase in the speed of the transistor by reducing the resistance of the collector".

Appellants submit that the term "selective" when interpreted in proper context with the complete disclosure of Marty, et al. denotes that a window 800 formed through the emitter functions as a mask during phosphorus implantation to form the SIC region in an intrinsic collector region 4. This window 800 restricts the *horizontal width* in which the dopant is introduced; it has no affect on the *vertical width* of the SIC region. As discussed above, Marty, et al. fail to disclose containing the high-diffusivity ion, implanted during the formation of the broad shallow SIC region, to a vertical width sufficiently narrow to avoid lowering collector base breakdown voltage.

The Examiner further alleges on Page 10 of the Final Rejection dated August 20, 2003, that "the use of phosphorus does not cause the implantation to be done so sporadically that the implant region contacts the base." Appellants submit that it is the combination of the high-diffusivity dopant and the high implant energy required by the process disclosed in Marty, et al. to implant the high-diffusivity SIC dopant through the base region 80, 81, 82 of the prior art device, which results in an n-type SIC region having a broad shallow profile and a tail of n-type dopants extending into the base region 80, 81, 82.

Further, Marty, et al. teach away from utilizing a heavier (low-diffusivity) dopant because a heavier dopant, using the Examiners' alleged implant concentration and energy, would destroy the overlying base region 80, 81, 82, therefore degrading the performance of the device to the point of inoperability. If a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no motivation to make the proposed modification. *In re Gordan*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984).

Therefore, the SIC region disclosed in Marty, et al. may not be modified to produce Appellants claimed n-type region having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the device is forward biased.

(c) Appellants' structure and method are not unpatentable, under 35 U.S.C. §103(a), over Marty, et al., since there is no motivation to modify the selectively implanted collector (SIC) disclosed in Marty, et al. to provide Appellants' n-type doping region having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the device is forward biased.

The Examiner alleges, on Page 4 of the Final Rejection dated August 20, 2003, that it would have been obvious to one of ordinary skill in the art to adjust the height of the SIC region disclosed in Marty, et al. in order to adjust the resistance of the collector region. Appellants submit that Marty, et al., do not disclose that the resistance of the collector region may be adjusted by adjusting the vertical height of the SIC region. The law requires that the prior art reference provide some teaching, suggestion or motivation to make the modification.

Here, there is no motivation provided in the disclosure of Marty, et al. to adjust the height of the SIC region to provide an n-type doping region having vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the base-junction is forward biased. The only disclosure regarding the formation of the SIC region and reducing the resistance of the collector is found in Col. 3, lines 65-67, and Col. 4, lines 1-5, of Marty, et al., in which Marty, et al. disclose that "selective overdoping of the collector (selective implantation collector) under the window of the emitter can be carried out in one or more implantation steps, thus contributing to an increased speed of the transistor by reducing the resistance of the collector." Appellants note that Marty, et al. make no reference to adjusting the height of the SIC region. "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." *In re Fitch*, 972 F.2d 1260, 1266 23 U.S.P.Q. F.2d 1780, 1783-84 (Fed. Cir. 1992).

Therefore, the Examiner has failed to provide motivation to modify the SIC region disclosed in Marty, et al. in a manner to produce Appellants' claimed n-type dopant 18 region having a vertical width W sufficiently narrow to avoid lowering collector-base breakdown voltage, as recited in Claims 24 and 45.

(d) Marty, et al. teach away from forming Appellants' transistor including an n-type region that having a vertically height sufficiently narrow to lowering collector-base breakdown voltage when the transistor is forward biased, since Marty, et al. disclose overdoping the collector region.

Appellants disclose that in conventional semiconductor device processing, there is a tradeoff between the Kirk effect and breakdown voltage. *See* Specification Page 2, lines 4-11. Conventional doping of the collector with an n-type dopant reduces the Kirk effect but introduces charge carriers that provide high electric fields that degrade the breakdown properties of the device.

Appellant's inventive n-type region 18 is doped heavy enough to significantly delay the onset of the Kirk effect, yet has a vertical width narrow enough to avoid creating a high-electric field of sufficient duration to degrade the breakdown characteristics of the device. Appellants submit that Marty, et al. disclose overdoping the collector region to delay the onset of the Kirk effect at the expense of reducing the breakdown voltage of the device, similar to the prior art disclosed in the Background of Invention section of the Appellants' specification.

Appellants observe that Marty, et al. disclose implanting phosphorus to increase the switching speed of the device without providing any instruction for avoiding a reduction in the breakdown voltage. Referring to Col. 4, lines 1-5, the SIC region formed in Marty, et al. is *overdoped* by one or more implant steps in an effort to increase switching speed of the device by implanting more charge carriers into the collector. By overdopping the collector, Marty, et al. are compromising the breakdown voltage of the device in order to increase the switching speed by offsetting the Kirk effect.

Appellants submit that since Marty, et al. disclose overdopping to increase the switching speed of the device without addressing breakdown voltage, Marty et al. teach away from Appellants' present invention, in which the n-type dopant profile has a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage, where the narrow vertical width has a reduced number of charge carriers yet still decreases the Kirk effect. A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore and Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983).

Marty, et al. interpreted by one of ordinary skill in the art depict a semiconducting device in which the speed of the transistor can be increased by introducing additional dopant at the expense of degrading the breakdown voltage. Therefore, Marty, et al. teach away from Appellants' claimed n-type dopant region 18 having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage when the transistor is forward biased and does not render Claims 24 and 45 unpatentable.

(e) Appellants' inventive n-type region having a vertical width sufficiently narrow to to avoid lowering collector-base breakdown voltage when the base-junction is forward biased is not a change in size that is within the level of skill in the prior art, since the inventive n-type is the result of Appellants' claimed method and not a change size corresponding to the mere scaling of a prior structure.

Referring to Page 4 of the Final Rejection dated August 20, 2003, the Examiner incorrectly cites *In re Rose*, 105 USPQ 237 (CCPA 1955) for the proposition that changes in size are generally recognized as within the level of ordinary skill in the art. Appellants' respectfully submit that the inventive n-type region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage is not a change in size that is within the level of skill in the prior art.

In re Rose is inapplicable to the present case since Appellants' n-type region 18 is the product of Appellants' inventive method and not a mere scaling of a prior transistor

structure. The claims heard by the court in *In Re Rose* were directed to an article of lumber packaging, in which the prior art disclosed substantially the same lumber packaging. The *sole difference* between the claims and the prior art in *In Re Rose*, was that the claimed lumber packing was of appreciable size to require lifting with a lift truck, where the lumber packing of the prior art could be lifted by hand. The court in *In re Rose*, held that the appealed invention was unpatentable, since the only difference between the appealed invention and the prior art related solely to the size of the lumber packing under consideration. *In re Rose* stands for the proposition that mere scaling of an article in not patentable subject matter and is inapplicable to the facts of the present appeal.

Appellants' claimed structure is not the result of upscaling or downscaling of a prior transistor's dimensions. The formation of Appellants' n-type dopant region, having a vertical width sufficiently narrow to avoid lowering the collector-base breakdown voltage when the base-junction is forward biased, is independent of the exterior dimensions of the transistor. Additionally, Appellants' n-type dopant region has a novel configuration that has not been formed prior to Appellants' structure, in which the inventive n-type region is doped heavy enough to significantly delay the onset of the Kirk effect, yet is narrow enough to avoid creating a high-electric field of sufficient duration to degrade the breakdown characteristics of the device. Therefore, Appellants' claimed n-type region is not solely a change in size that is within the level of ordinary skill in the art and the holding of *In re Rose* is inapplicable to the present appeal.

In view of the above remarks, Appellants respectfully submit that Claims 2, 3, 14, 22, 26, 27, and 33, on appeal, are patentable over the disclosure of Marty, et al.

III. The combined disclosures of Marty, et al. and Wen, et al. do not render Claims 5 and 29, on appeal, unpatentable under 35 U.S.C. §103(a).

Claims 5 and 29 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Wen, et al. Claim 5 is dependent on independent Claim 45 and Claim 29 is dependent on independent Claim 24. If an independent claim is non-obvious

under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate the claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. to anticipate the claimed invention, under 35 U.S.C. §102(e), apply equally well to the obviousness rejection of Claims 5 and 29 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief are incorporated by reference.

Wen, et al. do not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method or structure. Wen, et al. disclose forming a bipolar transistor where the base-collector capacitance is reduced by eliminating a portion of the collector contact layer 54b underlying the base electrode 66. Wen, et al., referring to FIG. 5, disclose a collector contact 54a formed within a substrate; a collector region 58; a base layer 60; and a emitter 61. The collector region 58, disclosed in *Wen, et al., does not include a deep collector region or an n-type doped region.* Additionally, Wen, et al. fail to teach or suggest a sub-collector region. Therefore, Wen, et al. fail to teach or suggest Appellants' claimed method including the steps of *forming an n-type dopant region within said collector region so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased*, and then *forming a base region,* as recited in Claim 45. Additionally, Wen, et al. fail to teach or suggest Appellants' claimed structure including an *n-type dopant region located atop and in contact*

with said deep collector and having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage, as recited in Claim 24.

In view of the above remarks, Appellants respectfully submit that Claims 5 and 29, on appeal, are patentable over the combined disclosures of Marty, et al. and Wen, et al.

IV. The combined disclosures of Marty, et al. and Ohmi, et al. do not render Claims 7 and 31, on appeal, unpatentable under 35 U.S.C. §103(a).

Claims 7 and 31 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Ohmi, et al. Claim 4 is dependent on independent Claim 45 and Claim 31 is dependent on independent Claim 24. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate Appellants' claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. to anticipate Appellants' claimed invention, under 35 U.S.C. §102(e), apply equally well to the obviousness rejection of Claims 7 and 31 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief concerning the deficiencies of Marty, et al. are incorporated by reference.

Ohmi, et al. do not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method or structure. Ohmi, et al. disclose in FIG. 1 a device having a substrate 1 including isolation regions 2; an

n-type semiconductor buried layer for collector potential 3 positioned atop the substrate 1; a field oxide 4 atop the N-type semiconductor buried layer 3; a base region 7 atop the oxide 4; and an n-type Si layer for forming the emitter region 15. Ohmi, et al. do not teach or suggest forming at least a sub-collector region and a collector region where the collector region includes a deep collector region and an n-type dopant region. Therefore, since Ohmi, et al. fail to disclose forming an n-type doped region, Ohmi, et al. fail to teach or suggest Appellants' claimed method.

Additionally, since Ohmi, et al. fail to disclose forming an n-type dopant region, the applied reference also fails to teach or suggest Appellants' bipolar transistor comprising an *n-type dopant region located atop and in contact with said deep collector and having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage*, as recited in Claim 24.

In view of the above remarks, Appellants respectfully submit that Claims 7 and 31, on appeal, are patentable over the combined disclosure of Marty, et al. and Wen, et al.

V. The combined disclosures of Marty, et al. and Rodgers do not render Claims 9, 10, 37 and 38, on appeal, unpatentable under 35 U.S.C. §103(a).

Claims 9, 10, 37 and 38 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Rodgers. Claims 9 and 10 are dependent on independent Claim 45 and Claims 37 and 38 are dependent on independent Claim 24. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type

region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate Appellants' claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. to anticipate Appellants' claimed invention, under 35 U.S.C. §102(e), apply equally well to the obviousness rejection of Claims 9, 10, 37 and 38 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief concerning the deficiencies of Marty, et al. are incorporated by reference.

Rodgers does not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method or structure. Rodgers discloses a V groove MOS transistor having a surface diffused drain and a common substrate source in which a heavily doped base layer and a lightly doped space charge region are provided between the drain and source regions. Rodgers discloses in FIG. 2 a P-type base region 16 formed over a common source 14, which may be the substrate of the device. A space charge or drift region 18 covers the base region 16. Appellants note that Rodgers does not make reference to a collector region; therefore Rodgers does not teach or suggest, forming *a collector region where the collector region includes a deep collector region and an n-type dopant region located therein.* Therefore, since Rodgers fails to teach or suggest an n-type dopant region within a collector region, Rodgers also fails to teach or suggest a method including *forming an n-type dopant region within a collector region containing a deep collector so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased*, and then *forming a base region,* as recited in Claim 45, on appeal.

Rodgers also fails to teach or suggest Appellants' bipolar transistor comprising a *n-type dopant region located atop and in contact with said deep collector and having an vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage,* as recited in Claim 24.

In view of the above remarks, Appellants respectfully submit that Claims 9, 10, 37 and 38, on appeal, are patentable over the combined disclosures of Marty, et al. and Rodgers.

VI. The combined disclosures of Marty, et al. and Akatsu, et al., do not render Claim 11, on appeal, unpatentable under 35 U.S.C. §103(a).

Claim 11 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Akatsu, et al. Claim 11 is dependent on independent Claim 45. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate Appellants' claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al., under 35 U.S.C. §102(e), apply equally well to the obviousness rejection of Claim 11 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief are incorporated by reference.

Akatsu, et al. do not alleviate the defects in Marty, et al., since the applied secondary reference fails to provide a method for forming an n-type region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased, as recited Claim 45. Akatsu, et al. do not alleviate the defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method, which includes forming an n-type dopant region within a collector region. Akatsu,

et al. disclose a process and structure that embrace the technique of outdiffusion from an implanted dielectric film. More specifically, Akatsu, et al. disclose a process in which a dielectric film is formed on the silicon substrate and then implanted so that the peak concentration of the implanted dopant species is closer to the silicon substrate/dielectric interface than the upper surface of the dielectric film. The process disclosed in Akatsu, et al. is far removed from Appellants' claimed invention.

In view of the above remarks, appellants respectfully submit that Claim 11 is patentable over the combined disclosures of Marty, et al. and Akatsu, et al.

VII. The combined disclosures of Marty, et al. and Sato do not render Claims 17 and 42, on appeal, unpatentable under 35 U.S.C. §103(a).

Claims 17 and 42 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Sato. Claim 17 is dependent on independent Claim 45 and Claim 42 is dependent on independent Claim 24. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate Appellants' claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al., apply equally well to the obviousness rejection of Claims 17 and 42 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief concerning the deficiencies of Marty, et al. to are incorporated by reference.

Sato does not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method or structure. Sato, et al. disclose a manufacturing method of bipolar transistors allowing omission of photolithographic process of the emitter electrode polysilicon and measurement of the characteristic of the transistor before forming metal electrodes. Sato, referring to Fig. 3(a), discloses a device comprising a P-type silicon substrate 1; N-type buried layer 2 atop the substrate; where a silicon collector region 3_1 is positioned atop the N-type buried layer 2. The collector region 3_1 disclosed in Sato does not include a deep collector region or an n-type dopant region. Sato does not teach or suggest *forming an n-type dopant region within a collector region containing a deep collector so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased*, and then *forming a base region*, as recited in Claim 45.

Since Sato fails to disclose forming an n-type doped region, Sato fails to teach or suggest Appellants' bipolar transistor comprising an *n-type dopant region located atop and in contact with said deep collector and having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage*, as recited in Claim 24.

In view of the above remarks, appellants respectfully submit that Claims 17 and 42 are patentable over the combined disclosures of Marty, et al. and Sato.

V.III. The combined disclosures of Marty, et al., Sato, and Ju do not render Claim 18, on appeal, unpatentable under 35 U.S.C. §103(a).

Claim 18 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Sato, and Ju. Claim 18 is dependent on independent Claim 45. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations

must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate the Appellants' claimed invention under 35 U.S.C. §102(e). Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. apply equally well to the obviousness rejection of Claim 11 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief are incorporated by reference. Appellants submit that Sato fails to fulfill the deficiencies of Marty, et al. to render Claim 18 unpatentable for the same reasons Sato failed to fulfill the deficiencies in Marty, et al. for the rejection of Claim 17, under 35 U.S.C. §103. Therefore, the remarks in Section VII of this brief concerning the deficiencies of Sato to render Claim 17 unpatentable are incorporated by reference.

Ju does also fails to alleviate the defects in Marty, et al. or Sato, since the applied secondary reference fails to provide a method for forming an n-type region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased, as recited Claim 45.

Ju does not alleviate the defects in Marty, et al., since the applied secondary reference does not teach or suggest Appellants' claimed method. Ju discloses forming an silicon on insulator (SOI) substrate involving a structure comprising a bulk silicon layer, a buried insulation layer over the bulk silicon layer, a silicon device layer over the bulk silicon layer, a silicon device layer over the buried insulation layer; and a mask layer over the silicon device layer; etching portions of the mask layer, the silicon device layer, and the buried insulation layer thereby forming openings and exposing portions of the bulk silicon layer; depositing polysilicon in the openings; removing a portion of the polysilicon in the openings; removing a portion of the polysilicon in the openings to form polysilicon sidewalls adjacent the silicon device layer and the buried silicon insulation layer and to form

gaps at least partially surrounded by the polysilicon sidewalls; depositing an insulation material in the gaps; and removing the mask layer.

Ju is far removed from Appellants' claimed method which includes the steps of: forming an n-type dopant region within a collector region containing a deep collector so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased, and then forming a base region, as recited in Claim 45.

In view of the above remarks, appellants respectfully submit that Claim 18 is patentable of the combined disclosures of Marty, et al., Sato, and Ju.

IX. The combined disclosures of Marty, et al. and Botula, et al. do not render Claims 20 and 44, on appeal, unpatentable under 35 U.S.C. §103(a).

Claims 20 and 44 stand rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Botula. Claim 20 is dependent on independent Claim 45 and Claim 44 is dependent on independent Claim 24. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a structure including Appellants' n-type region, as recited in Claim 24, or a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate the claimed invention. Appellants respectfully submit that the above remarks, concerning the deficiencies of Marty, et al. under 35 U.S.C. §102(e), apply equally well to

the obviousness rejection of Claims 20 and 44 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief are incorporated by reference.

Botula, et al. do not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed structure. Botula, et al. disclose an ESD device useful in high speed frequency applications where size and loading effects are a concern. More specifically, referring to FIG. 3, a trigger device is disclosed where a SiGe heterojunction bipolar transistor (HBT) is formed on a N-subcollector 302. The SiGe HBT comprises an N-type emitter atop a base region atop an N-collector 308. The collector region 308 disclosed in Botula, et al. does not include a deep collector region or an n-type dopant region. Therefore, Botula, et al. do not teach or suggest Appellants' claimed method or structure.

In view of the above remarks, Appellants respectfully submit that Claims 20 and 44 are patentable subject matter over the combined disclosures of Marty, et al. and Botula, et al.

X. The combined disclosures of Marty, et al. and Triveda, et al., do not render Claim 21, on appeal, unpatentable under 35 U.S.C. §103(a).

Claim 21 stands rejected under 35 U.S.C. §103(a) as allegedly unpatentable over Marty, et al. in view of Triveda, et al. Claim 21 is dependent on independent Claim 45. If an independent claim is non-obvious under 35 U.S.C. §103(a), then any claim depending therefrom is non-obvious. *In re Fine,* 837F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). "To establish a prima facie case of obviousness of a claimed invention all the claimed limitations must be taught or suggested by the prior art" *In re Wilson,* 424 F.2d 1382, 1385, 165 USPQ 44, 496 (CCPA 1970).

Appellants submit that Marty, et al. fail to teach or suggest a method of forming Appellants' n-type region, as recited in Claim 45. Marty, et al. fail to render Appellants' claimed invention unpatentable, under 35 U.S.C. §103(a), for the same reason that Marty, et al. fail to anticipate the claimed invention. Appellants respectfully submit that the above

remarks concerning the deficiencies of Marty, et al. apply equally well to the obviousness rejection of Claim 21 under 35 U.S.C. §103(a). Therefore, the remarks in Section I of this brief concerning the deficiencies of Marty, et al. to anticipate Claim 45 are incorporated by reference.

With respect to Claim 21, Trivedi, et al. do not alleviate the above defects in Marty, et al. since the applied secondary reference does not teach or suggest Appellants' claimed method. Trivedi, et al. disclose forming an interconnect structure from titanium nitride with tungsten silicide, where the inventive process is suited for use with a gate stack and a contact to an active area in the semiconductor substrate. Trivedi, et al. do not teach or suggest, *forming an n-type dopant region within a collector region containing a deep collector so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased*, and then *forming a base region*, as recited in Claim 45.

Trivedi, et al. do not alleviate the defects in Marty, et al., since the applied secondary reference fails to provide a method for forming an n-type region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased, as recited Claim 45.

Trivedi, et al. disclose forming an interconnect structure from titanium nitride with tungsten silicide, where the inventive process is suited for use with a gate stack and a contact to an active area in the semiconductor substrate. Trivedi, et al. do not teach or suggest, forming an n-type dopant region within a collector region containing a deep collector so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased, and then forming a base region, as recited in Claim 45.

In view of the above remarks, Appellants respectfully submit that Claim 21 is patentable over the combined disclosures of Marty, et al. and Triveda, et al.

9. Conclusion

The above arguments establish that all of the claims on appeal are enabled, definite and patentable over the substantive grounds of rejection raised in the Final Rejection. Appellants therefore respectfully request that the substantive grounds used in rejecting Claims 2-45, on appeal, made by the Examiner, be reversed by the Broad of Patent Appeals and Interferences.

Respectfully submitted,

Leslie S. Szivos, Ph.D.
Registration No. 39,394

SCULLY, SCOTT, MURPHY & PRESSER
400 Garden City Plaza
Garden City, New York 11530
(516) 742-4343

LSS:HAH:kc

APPENDIX

10. The claims on appeal for U.S. Application Serial No. 09/866,319, filed May 25, 2001

2. The method of Claim 45 wherein in said providing step (b) said vertical width of said n-type dopant region is less than about 2000 Å.

3. The method of Claim 2 wherein in said providing step (b) said vertical width of said n-type dopant region is from about 800 to about 1200 Å.

4. The method of Claim 45 wherein in said providing step (b) said n-type dopant region has a peak doping concentration and said collector has a peak doping concentration, wherein said peak doping concentration of said n-type dopant region is greater than said peak doping concentration of said collector.

5. The method of Claim 45 wherein in said providing step (c) said base has a peak doping concentration and wherein said n-type dopant region has a peak doping concentration that is lower than said peak doping concentration of said base.

6. The method of Claim 45 wherein in said providing step (b) said n-type dopant region comprises a dopant selected from the group consisting of As, Sb and P.

7. The method of Claim 6 wherein said dopant is Sb.

8. The method of Claim 6 wherein in said providing step (b) said n-type dopant region is formed by ion implantation and activation annealing.

9. The method of Claim 8 wherein said ion implantation is performed at an ion dose of from about 2E11 to about 1E13 cm^{-2} at an energy of from about 20 to about 150 keV.

10. The method of Claim 9 wherein said ion implantation is performed at an ion dose of from about 5E11 to about 5E12 cm^{-2} at an energy of from about 30 to about 50 keV.

11. The method of Claim 8 wherein said activation annealing is preformed at a temperature of about 900°C or higher for about 15 seconds or less.

12. The method of Claim 45 wherein in said forming step (c) said n-type dopant region is located adjacent the base-collector junction.

13. The method of Claim 45 wherein in said forming step (c) further comprises providing a lightly doped collector separating said n-type dopant region from said base.

14. The method of Claim 13 wherein in said forming step (c) said lightly doped collector has a vertical width of about 1000 to about 3000 Å.

15. The method of Claim 45 wherein said forming step (c) comprises forming a heterojunction.

16. The method of Claim 15 wherein said step of forming a heterojunction comprises depositing a SiGe-containing layer on said collector, said SiGe-containing layer comprising a polycrystalline region abutting a single-crystal region.

17. The method of Claim 16 wherein said forming step (d) includes forming a patterned insulator on said SiGe-containing layer, wherein said pattered insulator includes an opening that exposes a portion of said single-crystal region, and forming an emitter polysilicon on said patterned insulator and in said opening.

18. The method of Claim 17 wherein said step of forming a patterned insulator on said SiGe-containing layer comprises lithography and etching.

19. The method of Claim 16 wherein portions of said single-crystal region are doped so as to form extrinsic base regions therein.

20. The method of Claim 16 wherein said SiGe-containing layer comprises SiGeC.

21. The method of Claim 16 wherein said step of depositing a SiGe-containing layer is performed using a low-temperature deposition process selected from the group consisting of chemical vapor deposition (CVD), plasma-assisted CVD, atomic layer deposition (ALD), chemical solution deposition and ultra-high vacuum CVD.

22. The method of Claim 45 wherein said deep collector is formed by ion implantation and annealing.

23. The method of Claim 45 wherein in said providing step (a) said sub-collector is formed by ion implantation into a substrate or by epitaxially growing said sub-collector on a substrate.

24. A bipolar transistor comprising:
an emitter, a base, a collector, a base-emitter junction, and a base-collector junction, wherein said collector comprises a subcollector, a deep collector and a n-type dopant region between said sub-collector and said base-collector junction, said n-type dopant region is located atop and in contact with said deep collector and has a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when the base-junction is forward biased.

25. The bipolar transistor of Claim 24 wherein said n-type dopant region is located adjacent the base-collector junction.

26. The bipolar transistor of Claim 24 wherein said vertical width of said n-type dopant region is less than about 2000 Å.

27. The bipolar transistor of Claim 26 wherein said vertical width of said n-type dopant region is from about 800 to about 1200 Å.

28. The bipolar transistor of Claim 24 wherein said n-type dopant region has a peak doping concentration and said collector has a peak doping concentration, wherein said peak doping concentration of said n-type dopant region is greater than said peak doping concentration of said collector.

29. The bipolar transistor of Claim 24 wherein said base has a peak doping concentration and wherein said n-type dopant region has a peak doping concentration that is lower than said peak doping concentration of said base.

30. The bipolar transistor of Claim 24 wherein said n-type dopant region comprises a dopant selected from the group consisting of As, Sb and P.

31. The bipolar transistor of Claim 30 wherein said dopant is Sb.

32. The bipolar transistor of Claim 24 further comprising a lightly doped collector separating said n-type dopant region from said base.

33. The bipolar transistor of Claim 32 wherein said lightly doped collector has a vertical width of about 1000 to about 3000 Å.

34. The bipolar transistor of Claim 24 wherein said n-type dopant region provides a higher speed of the transistor by restricting base widening.

35. The bipolar transistor of Claim 26 wherein said sub-collector is on a semiconductor substrate.

36. The bipolar transistor of Claim 35 wherein said semiconductor substrate is a semiconducting material selected from the group consisting of Si, Ge, SiGe, GaAs, InAs, InP, Si/Si, Si/SiGe and silicon-on-insulators.

37. The bipolar transistor of Claim 24 wherein said n-type dopant region has a dopant concentration of from about 5E16 to about 5E17 cm^{-3}.

38. The bipolar transistor of Claim 24 wherein said n-type dopant region has a dopant concentration of from about 8E16 to about 2E17 cm^{-3}.

39. The bipolar transistor of Claim 24 wherein the transistor comprises a heterojunction.

40. The bipolar transistor of Claim 39 wherein said heterojunction comprises a SiGe-containing base layer on a silicon substrate.

41. The bipolar transistor of Claim 40 wherein said SiGe-containing base layer comprises a polycrystalline region abutting a single-crystal region.

42. The bipolar transistor of Claim 41, wherein said emitter comprises polycrystalline silicon contacting a portion of said single-crystal region through an opening in a patterned insulator.

43. The bipolar transistor of Claim 41 wherein said single-crystal region includes extrinsic and intrinsic base regions.

44. The bipolar transistor of Claim 40 wherein said SiGe-containing base layer comprises SiGeC.

45. A method of fabricating a bipolar device comprising the steps of:
(a) providing a structure comprising at least a sub-collector region, a collector region and isolation regions, said collector region including a deep collector region located therein;

(b) forming a n-type dopant region within said collector region so as to be in contact with said deep collector, said n-type dopant region having a vertical width sufficiently narrow to avoid lowering collector-base breakdown voltage and a dopant concentration sufficiently high to restrict base widening when a base-emitter junction is forwarded biased;

(c) forming a base; and

(d) forming an emitter.